

EXPERIMENTAL ON ABSORPTION SPECTRA FOR CERTAIN
RARE EARTH CRYSTALS AND THEIR MODIFICATIONS
WITHIN A MAGNETIC FIELD AT THE TEMPERATURE
OF LIQUID HELIUM

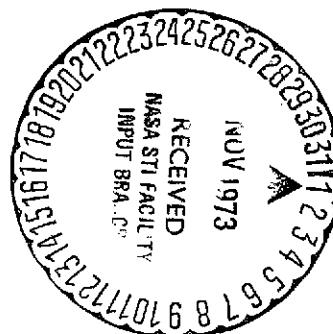
Jean B. Bédaride, H. Kamerlingh Onnes and W. C. de Haas

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16. Abstract Using a cryostat whose three tubes have been filled, respectively, with helium, hydrogen, and nitrogen in liquid form, the authors have conducted a spectrographic study of certain rare earth crystals, taking into account the particular effects produced by a temperature of 4.2°K (liquid helium). At that temperature, notably for zenotine, strong dissymetries appeared in the spectra for inverse circular vibration. As a result of their investigations, the authors conclude that, at very low temperatures, the rule by which magnetic influence upon circular vibration intensifies as thermic agitation decreases loses a major portion of validity.			
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ON ABSORPTION SPECTRA FOR CERTAIN
RARE EARTH CRYSTALS AND THEIR MODIFICATIONS
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Jean Becquerel, H. Kamerlingh Onnes and W. J. de Haas

The investigations that we are pursuing in Leyden are the natural consequence of the studies in spectroscopy and magneto-optics which were begun at the Museum in 1906 [1], continued in Leyden in 1908 [2], and extended up to the present period involving a temperature of 14°K (solid hydrogen). The experiments became possible at 4.2°K when liquid helium became transportable [3]. /758*

The cryostat now includes three concentric vacuum tubes, respectively filled with helium, hydrogen, and nitrogen in liquid form. The crystalline plates, placed at a convenient angle, are bathed in the helium of the innermost tube. The lower portion of this cryostat has only an external diameter of fourteen millimeters; it is placed between the polar pieces of a large Weiss electromagnet.

We have used a spectrograph with a system according to Rowland's diagram, whose lens has a 1.3 millimeter focal distance that functions by auto-collimation.

The crystals used until now have been four single-axis crystals: xenotime (spectrum due to erbium), tysonite, parisite, and bastnaesite (spectra due to didymum).

Effect of temperature. It was observed previously that the spectra of rare earth crystals, which are very rich in absorption bands at 80°K, are simplified when the temperature is lowered to 14°K. At 4.2°K (helium), these spectra become, as a whole, even more simple.

+Academy of Sciences, Session of November 16, 1925.

*Numbers in the right hand margin indicate pagination in the foreign text.

Some bands that passed through a maximum of absorption, but were still visible at 14°K, totally vanished. On the other hand, there are also bands which, having only appeared at a temperature that was already very low, increased in intensity up to 4.2°K.

Effect of a magnetic field. We have limited ourselves, until now, to the case where the optical axis of the crystal and the lum- /759 inous cluster are directed according to the lines of force.

The drawings represent, for temperature of 20.3°K and 4.2°K, two groups of bands of xenotine, within a field of 26.17 kilogauss. The spectrum with no field and the spectra for circular vibrations in an opposite direction are juxtaposed on the same photograph.

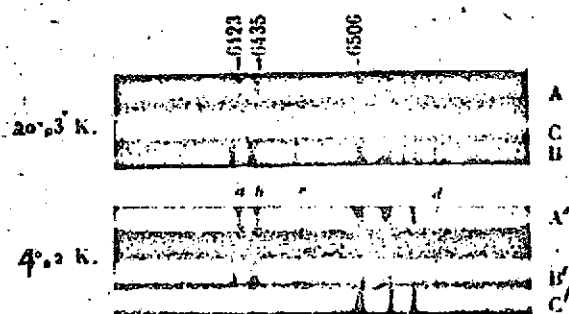


Figure 1. Xenotine, bands in red (primary spectrum network). A, A': spectra without a magnetic field, at 20.3°K. B', C': inverse circular vibration spectra within a field at 26,170 gauss (B and B' are circular vibrations in the same direction as the current).

An expected feature, which, nevertheless, would require verification, is that changes of period are independent of changes in temperature.

One remarkable phenomenon is the extent of the dissymetries of intensity for the components, corresponding to absorption of inverse circular vibrations. These dissymetries (which have already been studied up to 14°K) became so great at 4.2°K that, in the case of xenotine, the spectra for the two circular vibrations

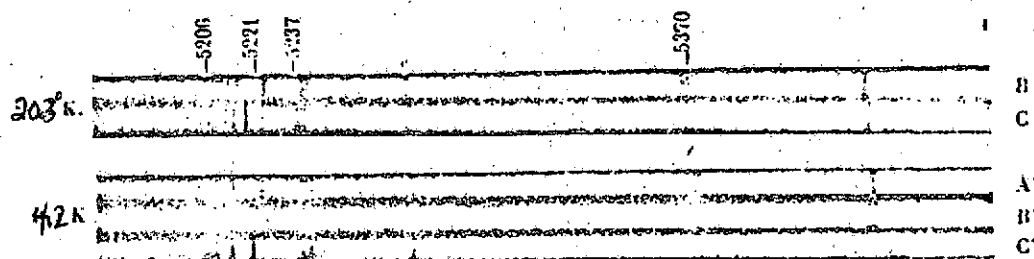


Figure 2. Xenotime, bands in green (secondary spectrum)
 A: spectra without a field at 4.2°K; B, C and B': inverse circular vibration spectra at 20.3°K and 4.2°K.

in inverse directions have totally different appearances. The dissymmetry often goes as far as total disappearance of one of the components, as one sees in the illustrations for a, b, c, d, and f. Dissymmetries for some bands already appear within a field estimated to be less than 2000 gauss. For other crystals, the dissymmetries are less sharp, although they are still very significant. /760

Up to 14°K, it appeared as a rule that the tendency toward dissymmetries always acted to reinforce the components displaced toward purple; among dissymmetries in the opposite direction observed at temperatures that were less low, the majority had changed direction, and some were attenuated. This allowed anticipation of a change of direction at a temperature lower than 14°K. This is precisely that which is observed, generally, at 14°K. However, we noticed two exceptions, one of which can be seen in c (illustration 2): at 20°K, the component displaced toward purple is the most intense, but the inverse occurs at 4°K.

Thus, the rule by which circular vibration accelerated by the

magnetic field tends to predominate when thermic agitation is decreased (a phenomenon that one tended to consider to be related to an orientation effect possibly related to para-magnetism) no longer stands as a general law. This is an unexpected and very curious fact.

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